CLAIMS

What is claimed is:

1. A phase shifter circuit for imparting a phase shift to an input signal applied at an input port such that a phase shifted signal appears at an output port, the circuit comprising:

an input port coupled to receive the input signal;

an output port coupled to provide the phase shifted output signal, the output port coupled to the input port, such coupling between the input port and output port having a characteristic input/output impedance;

a first quadrature port and a second quadrature port, the first and second quadrature ports coupled to one another, such coupling between quadrature ports having a characteristic quadrature port impedance, being different from the input/output port impedance;

a first impedance transformer coupled between the input port and a first one of the quadrature ports, the first impedance transformer transforming the characteristic input/output impedance across the input/output ports to the characteristic quadrature port impedance across the quadrature ports; and

a second impedance transformer coupled between a second one of the quadrature ports and the output port, the second impedance transformer transforming the characteristic quadrature port impedance across the quadrature ports to the characteristic input/output impedance.

2. An apparatus as in Claim 1, wherein the coupling between the input port and output port is provided by a branch line having the desired characteristic input/output impedance.

3. An apparatus as in Claim 2, wherein the coupling between the quadrature ports is provided by a branch line having the desired characteristic quadrature port impedance.

4. An apparatus as in Claim 1, wherein the coupling between the input port and the output port is provided by coupled lines.

5. An apparatus as in Claim 1, wherein the coupling between the quadrature ports is provided by coupled lines.

6. An apparatus as in Claim 1, wherein the first impedance transformer is implemented as a one-quarter wavelength section of transmission line.

7. An apparatus as in Claim 1, wherein the second impedance transformer is implemented as a one-quarter wavelength section of transmission line.

8. An apparatus as in Claim 1, wherein at least one varactor diode is coupled to at least one quadrature port.

9. An apparatus as in Claim 8, wherein an input bias voltage is applied to at least one of the varactor diodes.

10. An apparatus as in Claim 9, wherein the voltage of the input bias voltage determines an amount of phase shift imparted by the phase shifter.

11. An apparatus as in Claim 1, wherein at least one varactor diode is coupled to each of the quadrature ports.

12. An apparatus as in Claim 11, wherein an input bias voltage is applied to at least one of the varactor diodes.

13. An apparatus as in Claim 12, wherein the voltage of the input bias voltage determines an amount of phase shift imparted by the phase shifter.

14. An apparatus as in Claim 1, wherein the characteristic input/output impedance is 50 ohms.

15. An apparatus as in Claim 1, wherein the characteristic quadrature port impedance is 20 ohms.

16. An apparatus as in Claim 1, wherein a Radio Frequency (RF) choke is applied between the bias voltage port and one of the quadrature ports.

17. An apparatus as in Claim 1, wherein the characteristic quadrature port impedance is lower than the characteristic input/output port impedance.

18. A phase shifter circuit for imparting a phase shift to an input signal applied at an input port such that a phase shifted signal appears at an output port, the circuit comprising:

an input port coupled to receive the input signal;

an output port coupled to provide the phase shifted output signal, the output port coupled to the input port, such coupling between the input port and output port having a characteristic input/output impedance;

a first quadrature port and a second quadrature port, the first and second quadrature ports coupled to one another, such coupling between quadrature ports having a characteristic quadrature port impedance which is lower than the characteristic input/output port impedance, being different from the input/output port impedance;

a first impedance transformer coupled between the input port and a first one of the quadrature ports, the first impedance transformer transforming the characteristic input/output impedance across the input/output ports to the characteristic quadrature port impedance across the quadrature ports; and

a second impedance transformer coupled between a second one of the quadrature ports and the output port, the second impedance transformer transforming the characteristic quadrature port impedance across the quadrature ports to the characteristic input/output impedance.

19. A method for imparting a phase shift to an input signal applied at an input port such that a phase shifted signal appears at an output port, the method comprising the steps of:

receiving the input signal at an input port;

providing the phase shifted output signal at an output port, the output port coupled to the input port, such coupling between the input port and output port having a characteristic input/output impedance;

coupling a first quadrature port to a second quadrature port, such coupling between quadrature ports having a characteristic quadrature port impedance, being different from the input/output port impedance;

coupling a first impedance transformer between the input port and a first one of the quadrature ports, the first impedance transformer transforming the characteristic input/output impedance across the input/output ports to the characteristic quadrature port impedance across the quadrature ports; and

coupling a second impedance transformer between a second one of the quadrature ports and the output port, the second impedance transformer transforming the characteristic quadrature port impedance across the quadrature ports to the characteristic input/output impedance.

20. A method as in Claim 19, wherein the coupling between the input port and output port is provided by a branch line having the desired characteristic input/output impedance.

21. A method as in Claim 20, wherein the coupling between the quadrature ports is provided by a branch line having the desired characteristic quadrature port impedance.

22. A method as in Claim 19, wherein the coupling between the input port and the output port is provided by coupled lines.

23. A method as in Claim 19, wherein the coupling between the quadrature ports is provided by coupled lines.

24. A method as in Claim 19, wherein the first impedance transformer is implemented as a one-quarter wavelength section of transmission line.

25. A method as in Claim 19, wherein the second impedance transformer is implemented as a one-quarter wavelength section of transmission line.

26. A method as in Claim 19, wherein at least one varactor diode is coupled to at least one quadrature port.

27. A method as in Claim 26, wherein an input bias voltage is applied to at least one of the varactor diodes.

28. A method as in Claim 27, wherein the voltage of the input bias voltage determines an amount of phase shift imparted by the phase shifter.

29. A method as in Claim 19, wherein at least one varactor diode is coupled to each of the quadrature ports.

30. A method as in Claim 29, wherein an input bias voltage is applied to at least one of the varactor diodes.

31. A method as in Claim 30, wherein the voltage of the input bias voltage determines an amount of phase shift imparted by the phase shifter.

32. A method as in Claim 19, wherein the characteristic input/output impedance is 50 ohms.

33. A method as in Claim 19 wherein the characteristic quadrature port impedance is 20 ohms.

34. A method as in Claim 19, wherein a Radio Frequency (RF) choke is applied between the bias voltage port and one of the quadrature ports.

35. A method as in Claim 19, wherein the characteristic quadrature port impedance is lower than the characteristic input/output port impedance.